

# PATENT ABSTRACTS OF JAPAN

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## (54) METHOD FOR REMOVING COPPER FROM COPPER-CONTAINING IRON SCRAP

(57)Abstract:

PURPOSE: To easily remove the copper in copper-contg. iron scrap by heating iron scrap contg. copper products together with sulfur at a specific temp. in a nonoxidizing atm. while applying impact to the iron scrap in a rotary furnace.

CONSTITUTION: The iron scrap (motor cores, etc., sized about 3 to 20cm) contg. copper or copper alloy is put into the rotary furnace (cylinder furnace, etc.), where the iron scrap is treated for about 10 minutes to one hour by applying the impact thereto while the number of revolutions is adjusted to about 0.1 to 30rpm and by heating the iron scrap up to  $\geq 380^{\circ}\text{C}$  to  $\leq 515^{\circ}\text{C}$  together with the sulfur under the nonoxidizing atm. and maintaining the flow velocity of gases at about  $\geq 20\text{cm}$  per second. As a result, the copper in the copper-contg. iron scrap is easily and efficiently removed by forming copper sulfide which has a brittle property and executing magnetic separation treatment.

[Claim 1]A copper removing method from a copper-containing steel scrap characterized by heating at not less than  $380^{\circ}\text{C}$  to  $515^{\circ}\text{C}$  or less in a non-oxidizing atmosphere with sulfur while giving a shock to a steel scrap which copper or a copper alloy mixes in a rotary furnace.

## [Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to improvement of the method of separating copper from the steel scrap which copper, such as a motor core, a waste transformer, a waste car, electric motor waste, and machinery waste, or a copper alloy mixed, and

reviving as steel scraps with high purity.

[0002]

[Description of the Prior Art] Unless causing a crack and a surface flaw etc. will remove copper in order to use the scrap which copper, such as automobile waste, mixed as a raw material since it has influence harmful to quality if copper increases the hardness of articles of iron or steel, and elongation is reduced and it becomes 0.3% of the weight or more, only steel of low-grade quality can be manufactured. In order to remove copper from the scrap which copper, such as automobile waste, mixed, various methods are proposed, but there is a fault, like combination with preheating of a scrap which requires a lot of energies is difficult, and there is, and what it depends for on sorting by a help is the actual condition.

[0003] One of this invention persons solved these faults, separated copper by high separation efficiency and the amount of the low energy used, and proposed the method of obtaining a steel scrap with high purity (JP,2-285035,A). That is, it is a copper removing method from the copper-containing steel scrap consisting of the first process that heats with sulfur the steel scrap which copper or a copper alloy mixes in non-oxidizing atmosphere, and makes copper sulfuration, and the second process of separating the copper which compressed, or crushed and embrittled this scrap from a scrap. If the second process of compression or crushing is needed and also this invention is applied to large-sized copper-iron mixing scraps, such as a motor core and a waste transformer, in order that this invention may separate copper, It turned out that there is a phenomenon in which sulfuration stops only near the surface of a scrap depending on sulfuration conditions, sulfuration embrittlement of copper inside a scrap is checked, and there is not copper enough removal in a limping gait crack. For this reason, as a large-sized scrap, there is a problem to which a copper extraction ratio falls especially.

[0004]

[Problem(s) to be Solved by the Invention] This invention does not need the second process of compression or crushing, but it aims at providing the method of it being easily efficient and removing copper in a copper-containing steel scrap.

[0005]

[Means for Solving the Problem] A gist of this invention is a copper removing method from a copper-containing steel scrap heating at not less than 380 \*\* 515 \*\* or less in a non-oxidizing atmosphere with sulfur, giving a shock to a steel scrap which copper or a copper alloy mixes in a rotary furnace.

[0006]

[Function] Especially this invention is advantageously applicable in order to remove copper from large-sized copper-iron mixing scraps, such as a motor core and a waste transformer. As a copper presentation, copper is aimed at copper or the copper alloy which is 90 % of the weight or more for the copper wire for wiring, etc. It is not suitable for copper alloys, such as brass and bronze. Copper can apply the mixing ratio of copper and iron like automobile waste even to the high copper scrap which copper is mixing

50% or less not less than 10% like a motor core from the low copper scrap which is about 0.3%. However, it is more advantageous to aim at copper recovery as it is at a copper-refining process, when the copper-iron mixing ratio exceeds 50%. Although 3 cm or more 20 cm or less is preferred as for the size of a scrap, if it becomes not less than 3 mm even if smaller than 3 cm, it is applicable by using shock material, such as a stainless steel ball, simultaneously. Since it is necessary to lengthen holding time in a rotary furnace if the size of a scrap exceeds 20 cm, productivity is controlled, but it is possible to about 50 cm or less.

[0007]The sulfuration embrittlement conditions of a copper-iron mixing scrap are the material unit 1 of 300-1000 \*\* of temperature requirements, and sulfur - 100 kg/t, and atmosphere is a non-oxidizing quality. When the mixing amount of a material unit is small depending on the copper mixing amount in a scrap, there are few material units. Even if sulfur adds simple substance sulfur directly in a reactor with a powder supply machine etc., it may make a sulfur steam generate out of a furnace, and it may be led to the scrap stagnation position in a furnace. A sulfur steam is easily obtained by heating at not less than 300 \*\* 550 \*\* or less for example, in a sealing stainless steel container. Although inactive gas, such as nitrogen and argon, may be sufficient as a non-oxidizing atmosphere, the combustion gas which carried out incomplete combustion so that CO and H<sub>2</sub> might remain in 5 to 200% of CO<sub>2</sub> and H<sub>2</sub>O from a point of the heating efficiency of a scrap is preferred. Within a furnace, in order to contact and to make a scrap react to sulfur containing gas enough, while adjusting number of rotations to 0.1-20 rpm, the rate of flow of gas is also maintained 20 cm/s or more. However, since the contact time of gas and a scrap will become short if the rate of flow of gas becomes large exceeding 10 m/s, it is not desirable.

[0008]When this invention person did sulfuration embrittlement of the copper-containing scrap at 300 to 1000 \*\*, the copper sulfide generated at the elevated temperature over 515 \*\* found out having weak plasticity at the elevated temperature. For this reason, a surface sulfuration layer will turn into a precise layer, and will cover the scrap surface. So, it turned out that the sulphurous gases which are reactant gas become difficult to reach the inside of a scrap, and it is left behind as a large-sized scrap while internal copper has been unreacted.

[0009]Copper is wound around the iron core as a multiplex line by the motor core and the transformer. By sulfuration, that the volume of a copper part also expands and becoming the cause of blocking osmosis in the inside of gas also found out. However, when temperature was 515 \*\* or less, the generated copper sulfide found out having weak character, and completed the invention. That is, if few shocks are given making it react below 515 \*\*, the generated copper sulfide will exfoliate from a scrap and internal copper will be exposed. Sulfuration embrittlement is carried out by the reactant gas containing sulfur, and the exposed copper exfoliates by a shock again. Thus, sulfuration embrittlement of the copper is carried out to the inside of sequential. Although there should just be 10 cm or more of required impulse force by falling distance, 30 cm or more is preferred. Exfoliation becomes good so that falling distance is large, but since manufacture of a rotary furnace and the shock to a furnace body also become large, 2 m

or less is desirable practically.

[0010] Since the time for sulfuration [ a large-sized scrap ] will be taken too much if reaction temperature is lower than 380 \*\*, the reaction temperature needs to be not less than 380 \*\*. Also in order to remove the enamel layer which covers copper wire and to expose copper, the temperature beyond this is preferred. The optimal temperature requirement that fulfills productivity and detachability advantageously is 400-500 \*\*. Since the scrap [ sulfuration / the scrap / to the inside ] is crushed easily, an iron core portion is thoroughly separated from copper.

[0011] Sulfuration, surface sulfuration layer removal, and crushing can be simultaneously advanced with the same container, and a copper-containing compound steel scrap can be made to discharge as a steel scrap and a mixture of copper sulfide by scraps', such as the Linda furnace's and a rotary kiln's, fully working, and using as a reaction apparatus the rotary furnace which gives a shock mutually. As for the number of rotations of a rotary furnace, 0.1-20 rpm is preferred because of a reaction and shock exfoliation. If number of rotations is small, mixing of a scrap will also become insufficient, and since shock frequency is low, it is not desirable. If number of rotations is too large, a scrap will be easily stuck in a furnace and will become insufficient also with mixing and a shock. If number of rotations is too large, the holding time in a furnace of a scrap will become short, and it will become difficult to secure sufficient reaction time. Since copper sulfide is a powder-like, the mixture discharged from the rotary furnace carries out separate recovery of both by sieving.

[0012] The one where impulse force is larger has a large releasing effect of a sulfide, and can promote removing speed. In order to raise impulse force, it is preferred to insert in simultaneously heavy lifts, such as to install agitating plates of about 2-6 sheets to a rotary furnace wall surface, such as a rotary kiln, an iron block, a stainless steel lump. As for an agitating plate, it is preferred to install the fin whose height is 0.5 to 3 times the scrap length to the axis of rotation in parallel in the inside of a rotary furnace. Although the size of a heavy lift is the same as a scrap at least or more than its it is preferred, in 5 or more times, crushing force is too strong, and the shock to a furnace body becomes large. Although a globular form may be sufficient as shape, it is larger for crushing ability to be square. A larger large-sized motor core than an object scrap and the waste transformer itself may be used as a heavy lift. A stainless steel lump has the desirable character in which magnetic separation dissociates easily [ a steel scrap ], and it hardly reacts to sulphurous gases.

[0013] Although the in-furnace time to a rotary furnace is based also on conditions, such as a size of a scrap, reaction temperature, a sulfur addition, and impulse force, it is about 1 hour from 10 minutes. If in-furnace time is shorter than 10 minutes, heating and a reaction become insufficient, and if longer than about 1 hour, iron sulfuration will increase, and the problem which the sulfur concentration of a product steel scrap increases will occur. It is desirable in order that carrying out secondarily crushing of the mixture after discharge with shredding equipment, such as a ball mill and a hammermill, further after an elevated temperature or cooling from a rotary furnace may also make a

copper extraction ratio high. Since shredding equipment has far larger impulse force than the natural fall in a rotary furnace, in a rotary furnace, crushing separation also of the copper which has not carried out exfoliation separation thoroughly is carried out.

[0014]Even if crushing time is long in the case of secondarily crushing, there is no increase in sulfur. Since the strip also of the film-like sulfur compound adhering to the steel scrap surface is rather carried out by secondarily crushing, there is an advantage whose purity of a steel scrap improves. It may be strong although the impulse force of secondarily crushing may be comparable as the impulse force of a rotary furnace. The device which has powerful impact crushing power like a shredder crusher as a secondarily crushing device is also applicable. In this invention, the copper sulfide of the shape of a powder which carried out separation removal from the steel scrap can be used effective also in copper recovery by collecting and considering it as the raw material of a copper-refining process. For example, a top blows and it is good also as a raw material of a jet type continuation copper refining furnace.

[0015]

[Example]The mixture of the motor core whose length of the maximum part is an average of 8 cm, and a waste transformer was inserted in the rotary kiln with the wall made from stainless steel with 28% of average copper content, the incomplete combustion of the coke-oven gas was carried out, and the CO/CO<sub>2</sub> ratio heated as a non-oxidizing gas of 0.25. The rate of flow of combustion gas is 1.5 nm/s. It added continuously and sulphurous gases were made to generate so that a material unit may be set to 100 kg per ton to this combustion gas to a scrap in sulfur with a particle size of 3 mm or less.

[0016]The stainless steel plate manufacturing of 10-cm-high fin shape is attached to six places to the rotary kiln inner surface as an agitating plate at intervals [ circumferencial direction ] at the longitudinal direction. By the high velocity revolution of 12 revolutions per minute, it operated so that mean residence time might become 40 minutes. The excretions from a rotary kiln carried out the air dissolution of the sieve and sieve top with the oscillating sieve of 6 mm of openings. After changing reaction temperature, and operating in 350-550 \*\* and carrying out secondarily crushing of the sieve top of excretions with a hammermill further on the number of rotations of 600 rpm, and the conditions of 30 mm of openings, magnetic separation processing was carried out. It is shown in Table 1 including the separation result of copper and iron.

[0017]

[Table 1]

試料番号	反応温度(℃)	二次破砕	鉄中銅濃度(%)	銅除去率(%)	備考
1	—	なし	28	0	原 料
2	350	あり	18	35.7	比較例
3	350	なし	16	42.9	比較例
4	400	あり	3.5	87.5	本発明
5	400	なし	0.2	99.3	本発明
6	480	あり	1.6	94.3	本発明
7	480	なし	0.2	99.3	本発明
8	550	あり	12	57.1	比較例
9	550	なし	6.5	77.8	比較例

[0018]

[Effect of the Invention]By this invention, copper in copper-containing steel scraps, such as a motor core, is easily efficient, and it can remove. Copper can be collected and reused by also collecting the removed copper sulfide and performing a chemical treatment.

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